CLAIMS

What is claimed is:

1. A **method** for transmitting a **downlink signal** from a **communication station** to one or more **subscriber units**, the communication station including an **array** of **antenna elements**, each antenna element coupled to an **associated transmit apparatus** having **an input** and **an output**, the coupling of each antenna element being to the output of its associated transmit apparatus, the associated transmit apparatus inputs coupled to a **signal processor**, the method comprising:

for each particular signal processing procedure of a **set of different signal processing procedures**, each of the signal processing procedures being for processing the downlink signal to form **a plurality of processed downlink antenna signals**, each of the signal processing procedures including **weighting** the downlink signal in phase and amplitude according to a **corresponding weight vector**, each processed downlink antenna signal having an **intended antenna element** in the array, **repeating** the steps of:

(a) **processing** the downlink signal according to the particular signal processing procedure to form **a particular plurality of processed downlink antenna signals**;

(b) **transmitting** the downlink signal by **passing** each processed downlink antenna signal of the particular plurality of processed downlink antenna signals to its intended antenna element through the intended antenna element's associated transmit apparatus

the set of different signal processing procedures designed to achieve a **desirable radiation level** at any location in a **desired sector** during at least one of the repetitions of step (b) of transmitting.

2. The method according to claim 1 wherein the desirable radiation level is a **non-null** level.

3. The method according to claim 2 wherein the desired sector includes a **range of azimuths**.

4. The method according to claim 3 wherein the range of azimuths is the complete **range of azimuths** of the antenna array.

5. The method according to claim 4 wherein the signal processor includes a **programmable processor** and wherein each of the signal processing procedures comprises **running** a **set of programming instructions** in the programmable processor.

6. The method according to claim 4 wherein each corresponding weight vector used for weighting in each different processing procedure is a different weight vector of **a sequence of different weight vectors**, the weighting according to each corresponding weight vector producing the plurality of processed downlink antenna signals, the sequence of weight vectors designed to achieve a **desirable radiation level** at any location in a **desired sector** during at least one of the repetitions of step (b) of transmitting.

7. The method according to claim 6 wherein the weight vectors of the sequence of weight vectors are **pre-stored** in a **memory**.

8. The method according to claim 6, wherein the weight vectors of the sequence of weight vectors are computed from **a set of one or more prototype weight vectors**, the set of prototype weight vectors being **pre-stored** in a **memory**.

9. The method of claim 4 wherein

each different procedure of the set of different signal processing procedures also comprises a **set of post-processing procedures** of a **corresponding sequence of different sets of post-processing procedures**,

the corresponding weight vectors are essentially identical for each set of procedures of the sequence of different sets of signal processing procedures, and

the repetition of step (a) comprises

(i) **weighting** the downlink signal according to the corresponding weight vector to form **a plurality of downlink antenna signals**, and

(ii) **applying** a **different post-processing procedure** of one of the sets of post-processing procedures to each of the downlink antenna signals of the plurality of downlink antenna signals to form each processed downlink antenna signals of the particular plurality of processed downlink antenna signals.

10. The method of claim 9 wherein each set of post-processing procedures of the corresponding sequence of different sets of post-processing procedures comprises applying a **different set of phase shifts**.

11. The method of claim 10 wherein the phase shifts in each different set are **random** relative to each other.

12. The method of claim 9 wherein each set of post-processing procedures of the corresponding sequence of different sets of post-processing procedures comprises applying a **different set of time delays**.

13. The method of claim 9 wherein each post-processing procedure of the corresponding set of different post-processing procedures comprises applying a **different frequency offset**.

14. The method of claim 4 wherein the communication station is part of a **FDMA/TDMA system**.

15. The method of claim 14 wherein the communication station operates according to **a variant of the GSM communication protocol**.

16. The method of claim 14 wherein the communication station operates according to **a variant of the PHS communication protocol**.

17. The method of claim 4 wherein the communication station is part of a **CDMA system**.

18. The method according to claim 6 wherein the weight vectors of the sequence of weight vectors each have elements that have the same amplitude and have random phase.

19. The method according to claim 6 wherein the elements of each of the weight vectors of the sequence of weight vectors have equal magnitude.

20. The method according to claim 6 wherein the number of weight vectors in the sequence of weight vectors is the same as the number of antennas, the number of antennas denoted by *m*, and the weight vectors of the sequence of weight vectors are orthogonal.

21. The method according to claim 20 wherein the elements of each of the weight vectors of the sequence of weight vectors have equal magnitude.

22. The method according to claim 20 wherein the weight vectors of the sequence of weight vectors are formed from the rows of **a complex valued *m*-dimensional Walsh-Hadamard matrix**.

23. The method according to claim 20 wherein the weight vectors of the sequence of weight vectors are formed from the rows of **a real valued *m*-dimensional Hadamard matrix**.

24. The method according to claim 20 wherein the weight vectors of the sequence of weight vectors are formed from the **basis vectors** of **a *m*-dimensional discrete Fourier transform (DFT).**

25. The method according to claim 6 wherein each of the weight vectors of the sequence of different weight vectors is **designed** to provide a **particular desirable radiation pattern** within a **sub-sector** of the overall desired sector, all the sub-sectors covering the overall desired sector, each weight vectors minimizing a cost function of possible weight vectors which includes **an expression** of the variation from the particular desirable radiation pattern of the radiation pattern within the particular sub-sector resulting from transmitting using the weight vector.

26. The method according to claim 25 wherein the antenna array has elements which are substantially uniformly distributed, **a prototype weight vector** for **one sub-sector** is designed, and the other weight vectors of the sequence are **shifted versions** of the prototype obtained by **shifting** the prototype weight vector by **an amount** determined by the angular shift of the sub-sector from the prototype weight vector sub-sector.

27. The method according to claim 25 wherein the antenna array has elements which are substantially uniformly distributed, **a prototype weight vector** for **one sub-sector** is designed, and the other weight vectors of the sequence are **shifted versions** of the

prototype obtained by **shifting** the prototype weight vector by **an amount** determined by the angular shift of the sub-sector from the prototype weight vector sub-sector.

28. The method according to claim 6 wherein the sequence of weight vectors includes weight vectors designed for transmission to the **known subscriber units** of the communication station, the designed weight vectors determined from **transmit spatial signatures** of the known subscriber units of the communication station.

29. The method according to claim 27 wherein the set of representative weight vectors included in the sequence has fewer weight vectors than the number of known subscriber units.

30. The method according to claim 29 wherein the representative weight vectors are **determined** from the weight vectors designed for transmission to the known subscriber units, the determining of the representative weight vectors from the designed-for-subscriber-unit weight vectors using a **vector quantization clustering method**.

31. The method of claim 30 wherein the clustering method includes:

(i) **assigning** an **initial set of weight vectors** as a **current set of representative weight vectors**;

(ii) **combining** each designed-for-subscriber-unit weight vector with its **nearest representative weight vector** in the current set, nearest according to some **association criterion**;

(iii) **determining an average measure** of the distance between each representative weight vector in the current set and all the weight vectors combined with that representative vector;

(iv) **replacing** each representative weight vector in the current set with a **core weight vector** for all the weight vectors that have been combined with that representative weight vector; .

(v) **iteratively repeating** steps (ii), (iii) and (iv) until the magnitude of the difference between the average measure in the present iteration and the average distance in the previous iteration is less than a **threshold**,

the set of representative weight vectors being the current set when the magnitude of the difference is less than the threshold.

32. The method of claim 31 wherein the association criterion for nearness is the Euclidean distance and the core weight vector is the geometric centroid of all the weight vectors that have been combined with the representative weight vector of the current set of representative weight vectors during that iteration.

33. The method of claim 31 wherein the average measure is the average square of the distance

34. The method of claim 31 wherein the association criterion used for nearness is the maximal cosine angle and the core weight vector is the principal singular vector obtained from carrying out the singular value decomposition on all the weight vectors that have been combined with the representative weight vector of the present set of representative weight vectors during that iteration.

35. The method of claim 31 wherein the initial set of weight vectors are the unit amplitude weight vectors aimed at different uniformly spaced angles in the desired sector.

36. The method of claim 27 wherein the set of representative weight vectors forms a **first sub-sequence** of the sequence of weight vectors and the sequence of weight vectors further comprises a **second sub-sequence** of weight vectors.

37. The method of claim 27 wherein the second sub-sequence comprises a **particular weight vector** designed to provide a **particular desirable radiation pattern** in the desired sector, the particular weight vectors minimizing a **cost function** of possible weight vectors which includes **an expression** of the variation from the particular desirable radiation pattern of the radiation pattern within the sector resulting from transmitting using the weight vector.

38. The method of claim 37 wherein the particular desirable radiation pattern is a **near omnidirectional pattern**.

39. The method of claim 37 wherein the second sub-sequence is a **set of orthogonal weight vectors**.

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